Prince George Forest Region

Forest Resources & Practices Team

January 1998
Note #PG-15

FOREST RESEARCH NOTE

Regenerating Boreal Mixedwoods: Initial results of a Group Shelterwood Silviculture System in Trembling Aspen - White Spruce Stands

by Richard Kabzems

A group shelterwood is one option to regenerate trembling aspen - white spruce mixtures in the boreal forest.

This note describes first year results of one approach to keeping the 'mix' in boreal 'mixedwood' forests of north-eastern British Columbia.

What is 'mixedwood'?

A widespread and distinctive feature of the boreal forest are mixed stands of white spruce (*Picea glauca*) and trembling aspen (*Populus tremuloides*), often referred to as 'mixedwoods'. There can be horizontal mixtures of white spruce and aspen trees, or vertical mixtures where the white spruce are growing under taller aspen. A wide variety of combinations can be found. The different types of mixedwood reflect the more rapid height growth of young aspen, the ability of white spruce to establish and grow under aspen, greater shade tolerance of spruce, the longer life span of white spruce, variation in the time of establishment, and other ecological factors.

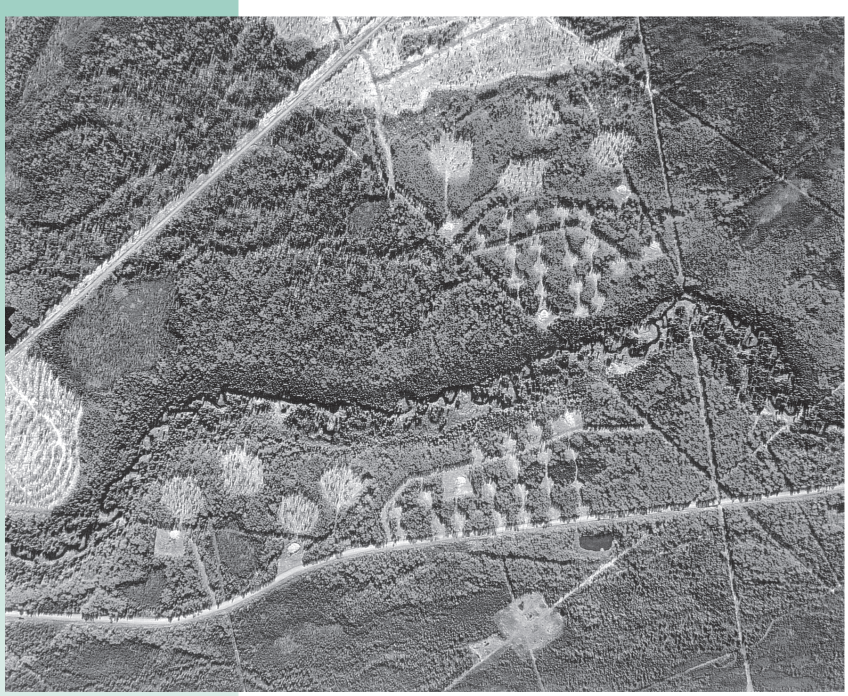


Photo 1 - Aerial view of Hoffard Creek group shelterwood trial

Why should we be interested in mixedwoods?

Boreal mixedwood forests are valuable economically and biologically. Both white spruce and trembling aspen are commercial tree species which support plywood manufacturing, sawmills, pulp mills and oriented strandboard facilities. The amounts of deciduous (mainly aspen) and coniferous (white spruce and pine) harvesting are similar in north-eastern British Columbia. The diversity of tree species and stand characteristics found in mixedwood stands provide important habitat for many plant and animal species (Stelfox 1995). Mixedwoods give us future options. Retaining a portion of the established white spruce while harvesting aspen can give us enhanced timber yields while meeting objectives for wildlife habitat, aesthetics and other resources.

How did we get the older mixedwood forests we see now?

Regeneration after wild fire was the starting point for most boreal mixedwood stands. Low intensity surface fires favor aspen regeneration (suckering) from lateral roots. If a seed source is available, spruce seedlings may establish immediately or over a period of 10 to 60 years (Kabzems and Lousier 1992, Lieffers *et al.* 1996a). A severe fire which consumes the forest floor creates a seedbed of mineral soil and ash which is very favorable for white spruce regeneration. The aspen regeneration after a severe fire is the same age as the white spruce, but rapidly overtops the spruce, due to the fast juvenile growth rate of aspen. (For additional information see Lieffers *et al.* 1996b, Thorpe 1992, Dix and Swan 1971, and Rowe 1956).

What is our experience with mixedwoods after harvesting?

With few exceptions, the amount of white spruce natural regeneration after harvesting has been poor and insufficient to replace the spruce that had been present. Stands which were previously mixedwoods have become dominated by aspen and balsam poplar after harvesting (Ball and Walker 1997).

The poor regeneration of the white spruce component of mixedwoods led to silviculture systems research by the Canadian Forest Service as early as 1924 (Waldron 1959).

Natural regeneration of white spruce under shelterwood has been successful in the boreal forest where a suitable seedbed and seed supply were present (eg. Lees 1964, Lees 1970, Ball and Walker 1995). The partial shading provided by retaining white spruce and aspen slows invasion of white spruce seedbeds by other plants, and reduces the vegetative competition for the white spruce seedlings which establish (Zasada 1972, Ball and Walker 1995).

The full exposure to sunlight and soil warming provided by clear-cut silviculture systems usually result in vigorous and plentiful aspen regeneration (Peterson and Peterson 1995). The amount and vigor of aspen regeneration generally declines with increasing density and more uniform distribution of the residual trees (Navratil 1996). The amount of white spruce retention sufficient to provide a seed source (basal areas of 4 to 8 m^2 /ha, Zasada 1972, Ball and Walker 1995) does not prevent deciduous regeneration from dominating early stand development. In Manitoba, thirty-seven years after cutting all deciduous stems and retaining 4.4 to 9.7 m^2 /ha of white spruce, regenerated stands were dominated by deciduous regeneration with basal areas of 12.7 to 16.2 m^2 /ha, compared to 0.2 to 0.3 m^2 /ha of coniferous regeneration (Ball and Walker 1997).

Why do we need new research about mixedwoods?

There has been a resurgence of interest in these alternatives to clear-cutting in response to an increased awareness of forest lands as ecosystems where the harvesting activities should be more similar to natural disturbances. Recent work has focused on retention of advanced white spruce regeneration in boreal mixedwoods (eg. Navratil *et al.* 1994).

The information available from decades of research and permanent sample plots in boreal mixedwoods provides us the opportunity to learn from the past. We can increase the success rate in meeting our objectives with the use of modern tools such as ecosystem classification, improved planting stock, and a wide variety of site preparation techniques.

This research project will explore one of the potential techniques to keep the 'mix' in boreal mixedwoods. To successfully regenerate both white spruce and aspen simultaneously on the same site requires a balance between creating conditions which enhance white spruce regeneration (partial shade providing vegetation control), with the full light and increased soil temperatures which optimize aspen regeneration and growth. A group shelterwood system with two har-

Silviculture system - is a program of treatments applied throughout the life of a forest stand. These treatments are designed to achieve specific objectives to meet management goals. Silviculture includes harvesting, regeneration and stand tending.

Under a **shelterwood** silvicultural system, some mature trees are removed in a series of separate cuts. The purpose is to regenerate a new, even-aged stand under the shelter of remaining 'leave' trees. The new growth may result from planting, natural regeneration from seed, or established advance regeneration from the pre-harvest stand.

In **uniform shelterwood**, individual leave-trees are distributed quite uniformly through a site to a specified density. Usually the smaller and poor-quality trees are removed. The more windfirm dominant and upper co-dominant trees of desirable form, vigor and seed production potential are kept until a final overstory removal.

In a **group shelterwood**, harvesting is applied in groups or patches.

Photo 2 - Boreal mixedwood

vesting entries may offer the opportunity to regenerate a mixed species stand, relatively uniformly aged, with both horizontal and vertical mixtures of trembling aspen and white spruce. This management scenario would allow economically viable timber harvesting systems to create boreal mixedwood stands in time and space, which meet forest management objectives for biodiversity, aesthetics and maximum sustainable productivity.

Where was this research done?

The study area is in the Fort Nelson Forest District. Two sites (SY 43, SY 45) were harvested in December 1996, near Hoffard Creek, approximately 40 km east of Fort Nelson.

What were the sites like before harvesting?

Both sites were mesic ecosystems ($ 01, AtSw - step moss, DeLong *et al.* 1990) in the Boreal White and Black Spruce moist-warm variant (BWBSmw2). Soil textures were loam or silt loam surface horizons over dense, clay-loam Bt horizons at 15 - 35 cm depth. Soils were classified as Orthic Grey Luvisols and Gleyed Grey Luvisols.

The stands had established naturally after wildfires about 90 years ago. The net merchantable volumes of aspen were 300 - 325 m^3/ha. The height of aspen dominants was between 24 and 28 m, with some exceptional heights to 32 m. White spruce heights were variable, ranging from regeneration less than 1.3 m in height to dominants of over 30 m. The majority of white spruce at the Hoffard Creek sites were advanced regeneration with diameters of less than 17.5 cm.

The distribution of stem numbers in SY45 indicated that some aspen veterans of the disturbance which initiated the stand were still present (‹ 7 stems/ha of aspen › 47.5 cm dbh). Occasional canopy gaps of sufficient size to enable aspen regeneration (‹7.5 cm dbh) were also found. These natural gaps were usually less than 0.04 ha in size. Aspen mortality in combination with local topography appeared to create situations where sufficient light reached the forest floor to stimulate aspen suckering.

The white spruce stem distribution in SY45 indicates that there are few survivors of the last major disturbance. White spruce seedlings did not begin to establish immediately after the disturbance. The delay in white spruce recruitment was probably due to: a) mortality and thinning of the aspen component, and b) an increase in suitable white spruce seedbeds, particularly well decomposed wood (Lieffers *et al.* 1996a).

How were the group shelterwood treatments created?

Two different sizes of circular openings were used in the group shelterwood, 0.13 ha (40 m diameter), and 1.0 ha (113 m diameter). With average tree heights of 27 m for the aspen, the small openings are slightly more than 1 tree height in size, and would have the majority of the opening in partial shade at some time during the day. The large openings of 1.0 ha, would be 3 - 4 tree heights in diameter, which would expose the

Figure 1. Changes in stand structure for a two pass group shelterwood.

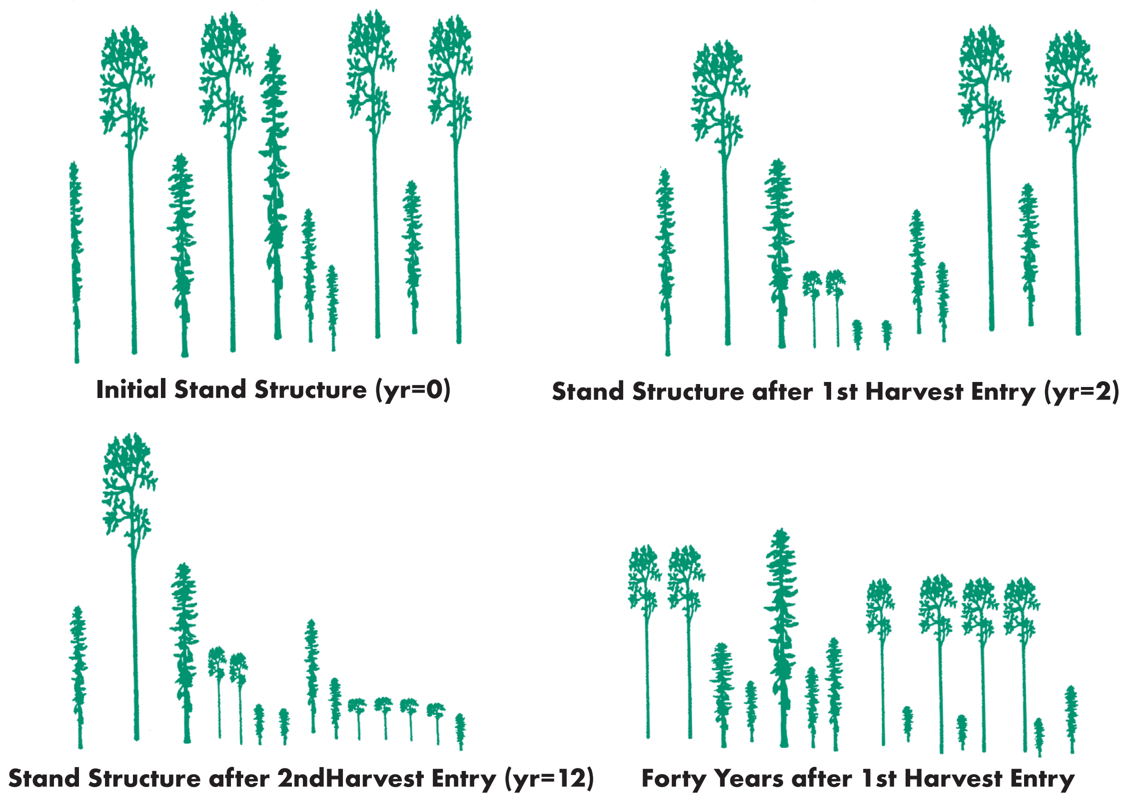
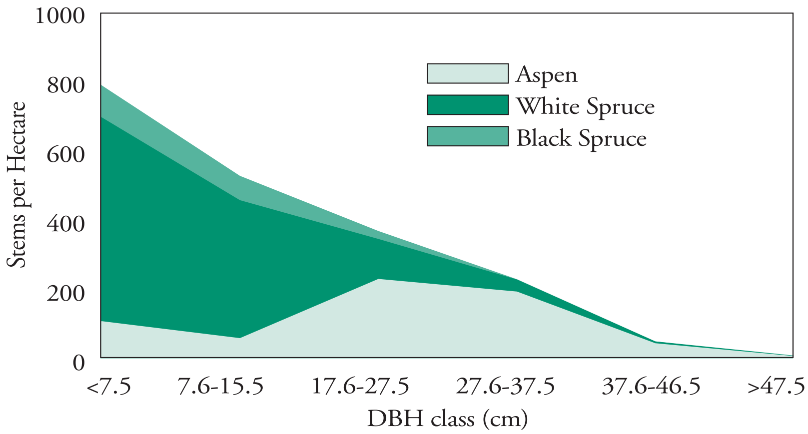


Figure 2. Pre-harvest diameter classes and species composition for SY45.



majority of the opening to full light conditions. White spruce less than 25 cm dbh were retained within the large openings, with a target of 100 stem/ha remaining after the harvest.

Harvesting of the Hoffard Creek sites began in November 1996 and was completed by early January of 1997. A conventional feller-buncher and grapple skidder combination was used to bring whole trees to the landing for processing.

What have we learned so far in this project?

In this note, only the components of the study which deal with aspen regeneration, white spruce regeneration, snags and coarse woody debris will be described. The objective and the methods used will be given for each of these study components.

Figure 3. Aspen regeneration in the first year after harvesting.

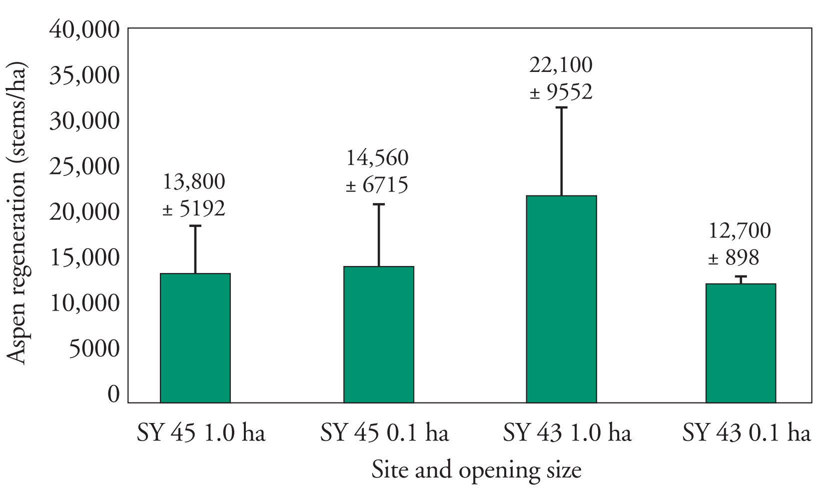


Photo 3. Harvesting of aspen in large opening treatment.

Aspen Regeneration

The objective of this component is to examine the survival and growth of aspen regeneration in two different sizes of group shelterwood openings in the BWBS.

Aspen regeneration was recorded along three continuous transects within each treatment opening. At three locations along each transect, aspen regeneration was measured for height and basal diameter.

The amount of aspen regeneration in the group shelterwood openings ranged from 13,000 to 22,000 stems/ha in the first year after harvesting. This was similar to other aspen sites in the Fort Nelson area which commonly have 15,000 to 40,000 stems/ha in the first few years after harvesting. Almost all the aspen regeneration at the Hoffard Creek sites had been browsed by moose to a height of approximately 65 cm in 1997.

Photo 4. Aspen regeneration in small opening treatment, August 1997.

There did not appear to be a significant difference in numbers of aspen regeneration between the 1.0 ha (113 m diameter) and 0.1 ha (40 m diameter) shelterwood openings in the first year after harvesting. There were no significant differences in first year aspen density and height between clearcuts and 18 m diameter circular openings in a 40 year old aspen stand in Ontario (Groot *et al.* 1997).

White spruce regeneration

The objectives are: 1) to quantify and monitor white spruce natural regeneration in the group shelterwood, and 2) to compare short and long term survival and growth of planted white spruce seedlings within the two different sizes of shelterwood openings.

One half of the openings (randomly selected) were planted with white spruce seedlings (1+0 415B) in July 1997 to a density of 1600 stems/ha. Seedlings along the monitoring transects were numbered and tagged. Height, leader growth, and basal diameter were measured in the fall of 1997. Annual re-measurements of the tagged spruce seedlings will be done for the first five growing seasons. Natural regeneration of white spruce will be monitored in nine subplots (2.25 m^2) within each treatment opening annually for the first five growing seasons.

Photo 5. Sampling for white spruce natural regeneration, August, 1997

Neither seed source nor seedbed were favorable for white spruce natural regeneration in 1997. Harvesting occurred on a snow pack after the ground was frozen enough to support heavy equipment. As a result, harvesting activities did not create exposed mineral soil seedbeds for the white spruce. The white spruce cone crop in the Hoffard Creek area was below average in the fall of 1997. Only one spruce germinant was observed in 144 subplots.

Snags and coarse woody debris

The objective of this component is compare the quantity and distribution of snags and coarse woody debris in naturally occurring mixedwoods to those occurring in the group shelterwood treatments.

Table 1. Pre-harvest values for snags within SY45 and SY43 and comparative data.

SY45 1995	**SY43**	**Norton & Hannon 1997 'old aspen'**	**Lee *et al.* 120 yr old mixedwood**
50 - 100 snags/ha 640 aspen stems/ha	130 - 170 snags/ha 890 aspen stems/ha	63 - 103 snags/ha 270 - 417 aspen stems/ha	66 snags / ha 535 aspen stems/ha

Snags and coarse woody debris are significant features for maintaining the long term productivity of boreal forests. For example, they provide key habitat for reproduction, feeding and shelter for a variety of wildlife species.

Prior to harvest, snags and coarse woody debris were recorded along continuous transects in the study stands. Tree species, size, and decay class were recorded.

Aspen was the dominant species for both snags and coarse woody debris (CWD). At this successional stage, self-thinning of aspen was the major source of new snags, and large wood pieces which fall to the forest floor. The majority of live aspen stems were between 17.5 - 27.5 cm dbh, while the majority of snags were < 17.5 cm dbh.

Photo 6. Sampling for snags and coarse woody debris, May 1996.

Table 2. Coarse woody debris (> 10 cm diameter) within SY45 and SY43 and comparative data from other studies.

Site 1995	**Species**	**Number of CWD/100 m transect**	**Volume (m^3/ha)**	**Merkens & Booth '97 mature aspen**	**Lee *et al.* 120 yr. old mixedwood**
SY45	Aspen	21	25-70	40.9 m^3/ha (> 5 cm)	13 pieces/100 m 101.4 m^3/ha
	White spruce	2	8		
SY43	Aspen	16	20-45		
	White spruce	2	5		

Future work

To complete this study, two more blocks are planned for harvest in the winter of 1997/98, near km 47 of the Fort Simpson Trail, approximately 65 km northwest of Fort Nelson.

The group shelterwood research trial is designed as a long-term study to last 20 years or more. Ten years after the first harvest entry, a second harvest is planned to remove approximately 40% of the original stand volume. Regeneration and stand development after the second harvest entry will be monitored for at least 10 years.

Reports will be prepared analyzing results of this research three, five and ten years after the harvest entries.

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Acknowledgments

Assistance and support of Canadian Chopstick Manufacturing Company, J.P. Logging, and the Fort Nelson Forest District is gratefully acknowledged. Funding was provided through the Research Component of Forest Renewal B.C.

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